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AUTHOR Preston, Ronald V.; Lambdin, Diana V.
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ABSTRACT

Mathematics for all students is a goal of the current mathematics education reform movement. But is today's reform also workable for all teachers? This report profiles two teachers who dropped out of field testing an innovative middle grades mathematics curriculum, the Connected Mathematics Project. These teachers are of interest because (1) their mathematics backgrounds seemed strong, (2) their espoused philosophies seemed compatible with the innovation, and (3) their work environments provided considerable support. The difficulties they encountered are described and recommendations are offered for helping teachers succeed with curricular reform. (Author/MKR)

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Mathematics for All Students! Mathematics for All Teachers?

Ronald V. Preston and Diana V. Lambdin

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(17th PME-NA, Columbus, OH, October 21-24, 1995)

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MATHEMATICS FOR ALL STUDENTS!
MATHEMATICS FOR ALL TEACHERS?

Ronald V. Preston, East Carolina University
Diana V. Lambdin, Indiana University

Mathematics for all students is a goal of the current mathematics education reform movement. But is today's reform also workable for all teachers? We profile two teachers who dropped out of field testing an innovative middle grades mathematics curriculum. The teachers are of interest because (1) their mathematics backgrounds seemed strong, (2) their espoused philosophies seemed compatible with the innovation, and (3) their work environments provided considerable support. We detail their difficulties and offer recommendations for helping teachers succeed with curricular reform.

One of the goals of the current mathematics education reform (NCTM, 1989; 1991) is to help students and the general public understand that all students can learn mathematics. Just as important might be this question—are today's reform recommendations workable for all teachers? Successful traditional teachers are finding much of the mathematics they are confident about teaching de-emphasized in favor of new—often unfamiliar—topics, while their tried and true methods are being challenged as well.

As external evaluators in charge of the nation-wide field testing of materials from a reform curriculum (the NSF-sponsored Connected Mathematics Project—CMP), we are involved in studying teachers' adaptation to change. CMP units of study engage middle school students in learning mathematics through contextualized investigations—and in reflective writing and oral communication about the mathematical concepts they encounter. Our field testing data include a variety of pre-, mid-, and end-of-year questionnaires from teachers; questionnaires three times a year from students; teacher calendars of daily plans; and classroom observations and feedback from individuals hired as site recorders.

Teachers' reactions to CMP have been diverse. Some teachers enthusiastically accept the program, finding a match with their own philosophies. Others experience philosophical differences with the approach or content difficulties with the mathematics. However, most teachers seem to agree—after trying the CMP materials—that the new approach is worthwhile. Though there is much to be learned from these teachers described (we have previously written about them—Lambdin & Preston, 1993; 1994; 1995), stories of teachers who have dropped out of the project can also inform the research community. Two of the nearly 100 teachers involved with CMP for at least one year—whom we will call Hannah and Laura[1]—dropped out during 1993-94. Their cases intrigue us because we initially believed they were strong candidates for field testing CMP. What went wrong?

[1] Hannah and Laura are pseudonyms for real teachers. All quotes from them are actual quotes and all details are accurate, although—in the interest of maintaining their anonymity—we have omitted mention of certain details that might identify them or their schools.

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After combing through our data, we developed a list of questions that we used in interviewing the recorders who had observed first-hand in Hannah's and Laura's classes. We also talked with Hannah and Laura themselves to get their perspectives on their CMP experiences. In this paper, we detail their difficulties and provide some recommendations for helping teachers succeed with curricular reform. (Due to page restrictions we have been reduced to including here only a small fraction of the evidence we have for many of our claims. Additional data will be presented at our PME presentation.)

Hannah's Case: Easier Said than Done?

Hannah came to the project as a teaching veteran of 18 years, with the past seven years being in middle school mathematics. Originally elementary prepared, Hannah earned her mathematics certification six years ago. Her philosophy and style of teaching (as self-described on a pre-project questionnaire) seemed largely in line with CMP:

> My main belief is that every student must be made to feel comfortable with themselves and the subject in order to grow and achieve. No question posed by a student is too trivial to warrant an explanation and can almost always be answered by another student. Understanding what to do is more important than calculations that are performed for tests.

Hannah's school provided plenty of collaborative assistance: regular meetings of all project teachers, a masters-level student/recorder who could help or observe in the classroom four days per week, a site director who offered content and methodological assistance, and a supportive administration. Hannah was (at least at first) a regular and productive contributor to weekly teacher meetings.

Hannah's dissatisfaction with the project came to our attention through strident self-report questionnaire responses at mid year; very different start-of-year and mid-year responses on the Stages of Concern Questionnaire (SoCQ) (Hord, Rutherford, Huling-Austin, & Hall, 1987); undeniably inflammatory comments from her students on mid-year questionnaires; and most of all, from observations of the site recorder. Hannah wrote, "students are uncomfortable with materials—explanations are not clear," and "Get rid of ACE [homework] #5—too difficult," and quizzes are "not clear enough to use." At mid-year, on her concerns questionnaire, Hannah marked "very true" for three items that we had previously identified as possible "red flag" indicators of dissatisfaction with the project:

> At this time I am not interested in learning about this innovation. I would like to know how to supplement, enhance, or replace the innovation. I would like to know how this innovation is better than what we have.

Students in Hannah's class reacted angrily on the mid-year questionnaire. Their responses to "What else would you like to tell the writers of CMP?" included

numerous adolescent vulgarities and even one death threat. Fifteen of Hannah's 28 students had more negative comments at mid-year than four months before. The recorder believed Hannah was actually the source of the students' discontent, claiming "the students are confusing their [negative] feelings toward the teacher with their feelings toward the project."

In a tape-recorded interview, the recorder suggested that though Hannah talked quite knowledgeably about mathematics education reform, she actually taught very little mathematics in her CMP class, leaving her students to flounder uncomfortably:

> People coming in might not know it's a math class ...she would talk about other things, not the math ...students and parents had complaints that they weren't doing any math. She knows about NCTM Standards. She knows everything. You'd get so motivated when you'd talk to her but when you'd go to her class it was like a bombshell. [Site Director] was shocked too....She doesn't believe in telling them [students], she doesn't guide. She'd let them go for weeks not knowing what the real answer is. Some of them that really need to know, they'd leave her class even more confused, because there's never closure...she doesn't pose other questions to focus them.

Shortly after mid-year, it was mutually agreed that Hannah would stop field testing CMP. In our subsequent interview with her, Hannah claimed that the curriculum "was jumping around a lot," that "there was no provision in that book for practicing basics, which is what a 7th grader needs," that "there was a lot of resistance" from students and parents because "parents couldn't help," and that "the book was not math friendly, especially if the student had trouble reading." Though Hannah believed "most of the NCTM standards definitely fit with the [CMP] philosophy," she also believed that the standards confirmed her own teaching philosophy, which she claimed to have espoused for decades: "when I saw it in the NCTM standards, I said, 'hey, I've been doing the right thing.'" Hannah did not note any conflict between these statements and her comment that CMP "was just so radical to the students that I could not overcome the resistance."

Hannah confirmed the recorder's observation that she had provided almost no direction in her CMP class. She also confirmed that her students floundered, learned little, and became increasingly hostile and belligerent. We believe Hannah may have thought that minimal teacher direction was a prerequisite for a student-centered environment such as that espoused by CMP. Perhaps she was confused because she had not attended the week-long summer inservice that provided an introduction to CMP. (Hannah also refused to read the Teacher Edition because she preferred to learn along with the students.)

Hannah talks as if she believes in active, student-centered learning, but she is unable to actually pull it off in her classes. She also seems to suffer somewhat from conflicting beliefs, alternately claiming that rules, computational practice, and algorithms are important and not important. Though she claimed that "under-

standing what to do is more important than calculations that are performed for tests," she was distressed that "fractions were thrown in almost immediately [in CMP]. I know they should have had fractions, they should be able to remember that, but there was no provision in that book for practicing basics, which is what a seventh grader needs." Upon closer investigation, it became clear to us that pressure from a district-imposed standardized test that emphasizes a very algorithmic, computational approach created some of this conflict for Hannah.

We believe that Hannah is an example (albeit extreme) of a teacher who claims (and probably even believes) that she is a proponent of new ways of teaching mathematics, but who finds it very difficult to actually implement them appropriately in her own teaching. Though Hannah talks convincingly about reform in mathematics education, she shows quite clearly that such changes are often much easier said than done.

Laura's Case: "I Think It's Great, But . . . "

Laura had been teaching for 12 years when she began to field test CMP. Originally an English major, she had returned to college for classes leading to a K-9 license with reading specialization. Then, after one year teaching elementary school, she became a middle school mathematics teacher. She reported 52+ quarter hours of math/math methods (the mathematics classes for her elementary degree "so captured my interest that I continued to take them after earning my teaching certificate"). In recent years, she has been involved in Math in the Mind's Eye, the Middle Grades Mathematics Project, and spent a sabbatical year working on an alternative assessment project.

Laura field tested CMP materials for nearly a year-and-a-half before dropping out. The first year, she taught seventh grade. On an initial questionnaire, Laura wrote:

> Activity based mathematics is my favorite way to teach where kids look at a situation or problem. Kids have access to manipulatives at all times. They're encouraged to use them, make models or draw pictures to help solve problems. I like to relate mathematics to history and current issues or other situations.

Her philosophy seemed to align well with that of CMP. In fact, to talk to Laura, to read her questionnaire responses, and to listen to descriptions from her on-site recorder was to experience a teacher so enthusiastic that she could have been a spokesperson for CMP. For example, in her first year of CMP, Laura declared, "I can't help but feel my kids will be much better prepared for algebra next year than with the [other math] book." On other occasions she volunteered "I love Investigation 6 because of the history tie in," and "I *really* like the "Filling and Wrapping" play dough and rice [activity]. YES IT WORKS!"

On the other hand, Laura sometimes sent other signals. She was torn between using CMP or favorite activities from previous years. When asked if she supplemented CMP she always answered affirmatively (e.g., "*Yes*, almost daily [picture

of sad face] 'sorry.' I need to work on sticking to the CMP material. It will save time."). Later, she wrote, "I try to use your materials faithfully, but I am readily distracted." She said that she supplemented CMP with "nifty, human interest things that spark excitement and connections." Laura also admitted spending insufficient time preparing, confiding that "my best lessons were ones that I'd thought about for a couple of days, not just in the car on the way to school" and "I need to see how do-able certain questions are for homework *before* I assign them. I've really screwed up on this when I didn't know."

Laura's SoCQ questionnaire revealed high concerns in every category (almost all above the 50th percentile)—in fact, higher than any of the 50+ other teachers for whom we developed concerns profiles. In her first year of CMP, she depended heavily on her recorder (who was also teaching CMP and willing to plan collaboratively). After her first year, when asked to provide advice for new teachers, she wrote "It *really* helped having [name] as our recorder. I was able to go to her with questions and concerns."

In her second year with us, Laura moved from 7th grade to 8th grade—where she taught one CMP class and several traditional algebra classes. Amazingly, by mid-November, Laura had spent only four days using CMP with her CMP class! Her calendar detailed the variety of things she had done instead (e.g., history of the word "algebra," pattern work, logic problems, fraction worksheets, survey project, film on Platonic solids, area bingo, area of silhouettes, and activities from two other sets of materials).

What contributed to this enthusiastic, if somewhat harried, CMP supporter's avoidance of the 8th grade project materials? We have identified several possible factors. The first and perhaps the most important factor is Laura's mathematical background. It appears that the mathematics of the eighth grade curriculum challenged her (see Ball, 1991) to the point where she was uncomfortable and thus avoided it. The eighth grade materials have a strong algebraic emphasis. Laura was experienced at teaching algebra traditionally, with an algorithmic approach, while CMP stresses learning algebraic ideas through investigation, which can be quite challenging. Upon further investigation we determined that Laura's alleged 52+ quarter hours of math/methods had actually focused much more on methods than on content. Her mathematics background was weaker than it looked. This helps explain why she was so often bothered, in both the 7th and 8th grade draft materials, by typographical errors and incomplete solutions. She was apparently quite insecure about teaching from materials that she could not rely upon for answers and explanations.

A second factor involves collaboration. In her second year of trialling CMP materials, Hannah was the only eighth grade teacher using CMP in her school. The recorder was no longer teaching and planning collaboratively with her, as in the previous year. This no doubt contributed to her decision to drop out of the project (see Little, 1987). A third factor relates to planning. By Laura's own admission she often waited until the last minute to put together a lesson, acknowledging that it "is really up to me to find the time."

A fourth factor is the student population. At the private school where Laura teaches, all the eighth grade students had taken algebra the previous two years, with mixed results. (Some ended up repeating the course in 9th grade.) Laura's 8th grade CMP class consisted of students counseled not to take algebra—the bottom 25% of the 8th grade. The recorder opined that Laura "believes that her kids won't 'get it.' She spends time going back over 'rules' for algorithms for rational number operations . . ."

Laura's case provides an example of a teacher who enthusiastically embraces the methods of reform, but whose limited understanding of mathematics, lack of collaborative support, and limited confidence when faced with errors in the materials led to insecurity, and eventually to avoiding the innovation entirely.

Discussion

Though Hannah and Laura had what looked to be above adequate mathematics backgrounds and appeared to agree philosophically with CMP, upon closer examination, we discovered problems in both these areas. Both women had become "mathematics specialists" through course taking and attendance at workshops, but the tenuousness of their mathematical expertise was revealed when they were confronted with unfamiliar mathematical ideas. Both talked enthusiastically and informatively about mathematics education reform, but had difficulty actually implementing their visions in the classroom. Hannah and Laura's cases concern us because indicators of trouble became apparent only in hindsight, when we began to look closely after they dropped out of the project.

Reform curricula seem likely to succeed only to the extent that teachers are helped to become knowledgeable and confident about mathematics content, and well supported in their efforts to use new methods of instruction (e.g., inservice and collaborative assistance). Content knowledge and pedagogical beliefs must be primary considerations for those who design inservice workshops and teacher manuals for innovative materials. It is also apparent that it is not easy to predict success with an innovation by the typical completing of forms and brief interviews. Use of the SoCQ, observations, and other means of identifying concerns and problems are important for identifying areas that can then be addressed (e.g., provide content assistance). Without significant efforts along these lines, it is looking more and more likely that reform success "for all teachers" may be an elusive dream.

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